

Mirror-based optical system for the 3rd and 4th generation synchrotron radiation sources

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We have established precision figuring and figure testing methods to fabricate total reflection mirrors for synchrotron radiation hard X-rays [1]-[5]. The spot size less than 30nm has been achieved at 15keV X-ray under the nearly diffraction-limited condition [6]. For the ultimate focusing of SPring-8 beam less than 10nm, we developed a compensation optical system consisting of multilayer mirrors and a novel phase compensator which can adaptively deform with nanometer precision to correct the wavefront error to satisfy the Rayleigh's quarter wavelength criterion. In the phase compensation optics system, an at-wavelength wavefront sensing method based on a phase retrieval was originally proposed and used. Achieved focal spot size was approximately $7 \times 8 \text{ nm}^2$ [7] - [12]. In the condensation of X-ray free electron laser, we have modified and improved our fabrication methods to meet mirrors longer than 500mm which are required especially in the SACLA focusing. 1 μm and 50nm focusing optics have already been installed and operated for the application researches [13][14].

We have also developed an advanced KB optics system consisting of 4 mirrors for an achromatic imaging which needs to satisfy Abbe's sine condition [15][16]. Performances have been confirmed to have an imaging resolution better than 50nm and a field of view as large as 20 μm . Coming upgrade of 3rd generation synchrotron radiation facilities must enable the multiple analysis because of an extremely high throughput of each analysis due to the unprecedented brilliance. Toward the multiple analysis, focusing optics should have flexibility to provide an appropriate sized beam for each analysis. We are developing an adaptive zoom condenser to change the spot size under the diffraction-limited condition [17].

Our current works and future plans will be shown in the development of synchrotron radiation reflective optics together with some application results.

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